

# The flammable fabrics problem

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The following paper deals with a type of accident whose etiology includes an aspect of modern technology—in this case the use of flammable fabrics in commercially manufactured clothing.

In its opening pages, the paper deals with one of the essential first steps in the development of countermeasures, namely, the large scale and systematic gathering of epidemiologic data. Without such data, the prevalence of the problem cannot be known, and in the absence of information on prevalence it is possible that an important cause of morbidity or mortality will go unnoticed or unchecked, or on the other hand, that disproportionate amounts of money and manpower will be devoted to countermeasures against relatively trivial causes. Moreover, it is only through sound and extensive epidemiological data that some understanding of etiology can be obtained.

Another important contribution made by this paper is the recognition that in the prevention of clothing burns, as in the prevention of many other kinds of accidental injury, several alternative countermeasures are available. All too often practitioners in accident prevention regard a single countermeasure as the only feasible one and as far more effective than it turns out to be when applied.

Although the paper recognizes the existence of alternatives, however, it falls short both in enumerating them and in evaluating them critically. Clothing burns involve three factors: flammable fabric, the behavior of the wearer, and the presence of a source of heat. Although the paper discusses legislation (to eliminate flammable fabrics) and education (to modify the behaviour of the wearer), it says nothing about legislation, education, or other efforts to eliminate or provide safeguards against the heat source. However, there are convincing data to indicate that the elimination of open flames (through the substitution of central heating for fireplaces, for example) is one of the most effective countermeasures against clothing burns. Such a reduction of open flames may be achieved through legislation (against certain types of space heaters) or technological changes.

Moreover, although it is important to recognize that there are alternative countermeasures, it is even more important to distinguish their relative effectiveness. In discussing education, for example, it is important to note that few, if any, systematic studies have shown that an educational program—whether in driver education or in home safety—has shown any reduction in accidents whereas legislative efforts have been highly successful, especially when the countermeasure has involved a modification of a technological practice. Certainly in the case of flammable clothing, an

educational program would have to be addressed primarily to those who have been recognized as “hard to reach” and who live surrounded by environmental hazards which cannot be removed by education alone.

In its treatment of legislative efforts, this paper leaves a number of questions unanswered. Why, for example, did nine years elapse between the “cowboy chaps” incident and the enactment of legislation against flammable fabrics? And why was the initial legislation so inadequate as to require amendment, which did not occur until 13 years later? Despite the very high effectiveness of legislative countermeasures against industrial accidents, many people involved in public health and other areas related to safety seem reluctant to initiate legislation that might effectively remove certain environmental hazards. Perhaps because of their own professional traditions, they prefer to rely on education and publicity programs, despite their demonstrated ineffectiveness. It is possible that a clearer understanding of the legislative process, coupled with the identification of special interest groups which oppose such legislation, might lead to far more countermeasures.

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Changing conditions of contemporary life produce continuous change in the magnitude and nature of health problems. Today, accident prevention has developed into a medically oriented program concerned with what is now recognized to be one of the major health problems affecting the American people.

Burns involving the ignition of clothing constitutes a significant segment of the accident problem. In today's United States population of more than 200 million, an estimated 3000 deaths and 150 000 injuries occur annually from burning clothing. Injuries resulting from exposure to ignited clothing are more prevalent at both ends of the age spectrum and vary with the capacity of the victim to look after himself. Likewise, the ability to minimize the injurious effects, should clothing ignition occur, varies with age. The following studies seem to lend support to the consideration that more probably can and should be done, in the prevention of clothing burns than in any other category of burns.

One burn study, currently being conducted by the Injury Control Program of the US Public Health Service in collaboration with the University of Michigan was initiated in 1964 and involves, in the form of a National Burn Information Exchange, major burn treatment centers throughout the United States. As of 1 May 1968, the 15 participating hospitals had reported about 4900 burn cases to the exchange. More than 50% of these cases were associated with clothing ignition.

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A burn study in Tennessee indicated that, of the 308 burn cases reviewed, clothing ignition burns to Tennessee children accounted for 40.8% of the cases. In the study, Hopkins<sup>1</sup> assigned an "avoidability rating" for various types of burns. The preventability of clothing and flame burns ranked highest. In terms of "severity rating" by type of burn accident, clothing burns ranked highest. In fact, the severity of clothing burns was nearly double that of the next type of burn, involving hot substances.

A total of 231 consecutive patients with second and third degree burns admitted to the University Hospital in Oklahoma City was studied during a five year period.<sup>5</sup> Of the total, 66% (153) involved the ignition of clothing. Sixty one per cent (141) of the burn victims were under 12 years of age, 39% being of pre-school age. The female to male death ratio was 31 to 1.

A joint study of clothing flammability conducted by the American Academy of Pediatrics Committee on Accident Prevention and the National Fire Protection Association Committee on Wearing Apparel reported 84 burn cases from ignited clothing, 41 of whom were children under 16 years of age.<sup>2</sup>

In California, a three year analysis was made of deaths to children through the age of 19 from burns from ignited clothing. A total of 76 deaths included five boys and 59 girls less than 9 years of age and 12 girls in the group from 10 through 19.<sup>3</sup>

Cost of medical treatment, not including rehabilitation costs, is exceedingly high. Injury from burning clothing often involves some of the limb flexures and all too often the hands, face, and neck of the victim. Contractures in these sites require frequent readmission to a hospital to correct the skin shortage with further plastic surgery procedures. An example of the complex and time consuming medical treatment necessary was that of a 7 year old girl who received burns to 55% of her trunk and all her limbs.<sup>4</sup> In 15 months, she received 15 skin grafts, and 10 further operations between the age of 8 and 13 were required to correct the contractures. Medical expenditures for one victim may run as high as \$60 000.

Medical technology has done much to alleviate the adverse physical results of non-fatal burns, although the cosmetic damage often remains quite obvious. Furthermore, the mental anguish and stress are often very serious. Burn disfigurement often brings on feelings of guilt, insecurity, loneliness, and inferiority. Colebrook states, "Almost inevitably a severe burn leaves a permanent scar on the patient's life and personality. This may be further accentuated by prolonged absence from school and resulting mental backwardness, or in adults by loss of earning ability or enforced changes of occupation".<sup>4</sup>

### Flammability of clothing fabrics

Classifying one fabric as safe and another as unsafe for use in clothing is misleading, because many factors must be considered. In general, the hazard depends not only on the material or basic

fiber but also on weight and construction. Also, the magnitude of risk to the potential victim greatly depends upon the situation in which the fabric is being used. In attempting to classify general types of basic fibers as to their ease of ignition and, ultimately, their potential for injury, three distinct but often overlapping groupings can be defined.

#### GROUP I

Materials made of cotton and rayon generally possess the fastest burning characteristics. With few exceptions, the major clothing ignition problem involves ordinary, everyday wearing apparel made from these and similar types of material.

#### GROUP II

Other manmade fibers vary greatly in their burning properties. Except for those few synthetic fibers that are inherently flame resistant in their natural state, the synthetic fibers possess a somewhat lower potential for injury than those in group I. Thus, the widely held impression that synthetics are a greater risk is not generally true.

#### GROUP III

Fabrics made of protein animal hair, pure silk, and wool are the least hazardous of all except for the inherently flame retardant and chemically treated cellulosic fibers.

### Fabric and clothing factors affecting burn incidence

Although the incidence of burns is associated closely with type of fabric, this is not determined solely by fiber content. The following characteristics must also be considered.

#### PILE OR NAPS

"The exposure of flame to a napped surface consisting of very loose fibers, with considerable air space between them, results in a condition where the napped surface will ignite very readily and flames will race across the brushed surface at an incredible rate of speed".<sup>5</sup> The "cowboy chap" and the "torch sweaters" were garments of this nature. These were made of high pile rayon, the surface of which greatly enhanced their burning characteristics.

#### WEAVE AND WEIGHT

The weave or fabric structure largely determines the flammability of wearing apparel and is determined by the manufacturing process: weaving, knitting, twisting, lacemaking, fiber bonding, or felting. In the case of synthetics, however, weave is not as significant a factor in the rate of burning as it is with the most widely used clothing fabrics: cotton, rayon, and wool.<sup>5</sup>

In general, the heavier the fabric, the higher will be its flame resistance, the slower its burning characteristic, and the less its ability to ignite from momentary contact.

#### CLOTHING DESIGN

Garment design greatly influences the likelihood of ignition. Long, loose fitting garments, especially women's night dresses, dressing

gowns, housecoats, full skirted dresses, and underclothing, are more dangerous than closely fitting garments, such as men's pajamas and trousers. Flame contact is much more readily made when a garment is of the type that swings away from the wearer, and the greater amount of air surrounding the loose clothing supports and increases the rate of flame spread.

#### RATE OF FLAME SPREAD

Speed of burning, although an important factor in clothing burns, has perhaps been somewhat overemphasized. The quantity of fuel must be considered in relation to the speed of burning before full potential of the hazard can be assessed. A very sheer and lightweight fabric may ignite easily and burn rapidly but not produce enough heat to cause further clothing ignition or to inflict deep burns to the victim. The rate of flame spread depends also on the total dimensions of exposed fabric material.

#### Upsurge of legal concern

As a result of "cowboy chap" incidents of 1945, which caused a number of deaths and injuries to children, the Flammable Fabrics Act was enacted and became effective on 1 July 1954. The purpose of the act is to reduce the danger of injury and loss of life by providing, on a national basis, standard methods for testing and rating the flammability of textile products of clothing used and thereby discouraging the use of any dangerously flammable clothing textiles. The act was designed to cover only those fabrics coming in contact with the body and therefore excluded industrial fabrics and fabrics used for toys, drapes, bedding, and floor coverings in addition to hats, gloves, footwear, and interlinings. The act's success in removing this type of extremely hazardous fabric item from the market is not well defined, however.

#### APPROACHES TO SOLVING THE PROBLEM OF CLOTHING BURNS

No single approach is sufficient to reduce the consequences of clothing flammability. Legislation, fact finding, information exchanges, use of less flammable fabrics, education, research, and personal involvement are considered here, but other approaches must be identified, tested, and evaluated.

#### LEGISLATION

Public Law 90-189, "To amend the Flammable Fabrics Act to increase the protection afforded consumers against injurious flammable fabrics", which was signed by President Johnson on 14 December 1967, holds much promise of reducing the problem of burns from fabrics. The amended act now includes all articles of wearing apparel and interior furnishings. Interior furnishings are defined as any type of furnishing made in whole or part of fabric or related materials, including paper, plastic, rubber, synthetic film, or synthetic foam, that are intended for use in homes, offices, or other places of public assembly or accommodation.

The amended act established no new standards or regulations for flammability, but

delegates to the Secretary of Commerce the responsibility and authority for establishing regulations or flammability standards to protect the public.

#### FACT FINDING

The act directs the Secretary of Health, Education and Welfare to conduct a continuing study and investigation of the deaths, injuries, and economic losses resulting from accidental burning of products, fabrics, or related materials and to report these findings annually to the President and the Congress. These responsibilities under the Flammable Fabrics Act will be carried out by the Public Health Service's Injury Control Program through the following activities: investigations by multidiscipline surveillance teams in strategic areas throughout the country, investigations associated with burn centers that treat the more severe burns, a national burn injury survey, special studies done on cases of coroners and medical examiners, and an economic analysis.

#### INFORMATION EXCHANGE

The Information Council on Fabric Flammability is an outgrowth of the Conference on Burns and Flame Retardant Fabrics held in December 1966 at the New York Academy of Medicine. Its purpose is to work for the reduction of morbidity and mortality from burns caused by flammable fabrics and related materials by encouraging the exchange and dissemination of information concerning injury statistics, research findings, testing methods, and public information programs to and from the various disciplines desiring to participate.

#### USE OF LESS FLAMMABLE FABRICS

When choosing clothing or fabrics for their family and home, consumers consider such characteristics as permanent press, stain resistance, and wash and wear properties. But the safety of a garment is rarely considered by the consumer, the parent, or even the professional who is in a position to give consultation and exert influence. For high risk groups, the very young and the elderly, these factors should receive serious consideration. Parents and those who provide professional care or guidance for the high risk population can do much toward minimizing the possibility of burns from ignited clothing by considering the safety of the garments selected.

#### RESEARCH

The future for less flammable fabrics is promising because American chemical and textile technology has made possible the use of durable flame retardant fibers and fabrics. These fabrics are either inherently flame retardant or are made less flammable by the application of chemicals. In nearly all cases, the fabric remains resistant to flame during the useful life of the fabric. Currently, a number of techniques for providing durable flame retardancy are available, and many others are now being tested in the laboratory. The major approaches, however, are through the manufacture of inherently flame retardant synthetic fibers

identified as modacrylic fibers, and by chemically treating cotton and predominantly cellulosic fibers and blending of inherently flame retardant synthetic fibers into those fibers that are flammable or into fibers that cannot be made less flammable through treatment. To be included in this group is a fiber that seldom is involved in burn causation because of its natural flame resistance.

#### EDUCATION

Educational efforts aimed at accident prevention include information on burns, emphasizing both their immediate and long term physical and psychological effects. Since fires and resulting burns are the principal cause of mortality to children, educational programs should be aimed particularly at parents of young children. The responsibility for developing and implementing such programs lies with health departments, physicians, hospitals, safety organizations, and others comprising the community team.

Parental habits and attitudes are often a factor in burns to children. Parents seem to accept burns to their children as a part of the learning process and an inescapable fact of life. They often fail to recognize the need for environmental changes designed to protect the curious and experimenting child. Lack of adult supervision and proper discipline of the child along with the failure of parents to understand and implement educational opportunities about the hazards of burns needs study.

The education of the child as to the nature of the hazards to which he is exposed is important, and parents and teachers vary greatly in the extent to which they attempt this. The physician, and especially the pediatrician, has much to contribute in this area, not only with the child and his parents, but also in the community.

The initial responsibility for informing the child about burn prevention lies with the parents, but the final responsibility in cases of accidental clothing ignition in an unsupervised situation lies with the child to respond in the previously taught manner. Only through the foresight of a parent or responsible person will this knowledge be imparted to those needing it most.

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